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An approach to interfacing data bases in WWMCCS ADP.

McCoy, Sheila K.

Monterey, California. Naval Postgraduate School

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THESIS

AN APPROACH TO INTERFACING
DATA BASES
IN
WWMCCS ADP

Sheila K. McCoy

March 1984

Thesis Advisor: S. H. Parry

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could translate to and from the EDI standard data set could exchange data with any other participating command. Implementation of this sort of system would facilitate interfaces among commands while not limiting participating commands to specific hardware, software, or data base management systems. The thesis proposes the EDI concept as a step toward realization of better data distribution and management in WWMCCS ADP.

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An Approach to Interfacing Data Bases in WWMCCS ADP

Sheila K. McCoy
Lieutenant Commander, United States Navy
B.A., University of Rhode Island, 1970

Submitted in partial fulfillment of the
requirements for the degree of

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March 1984

ABSTRACT

Evolving requirements including the development of the Joint Operation Planning and Execution System (JOPES) are forcing the WWMCCS ADP community toward the development of a distributed data base approach to information management. In this thesis the Electronic Data Interchange (EDI) concept is examined as a proposed system for realizing a distributed data approach. Using the EDI concept, any command which could translate to and from the EDI standard data set could exchange data with any other participating command. Implementation of this sort of system would facilitate interfaces among commands while not limiting participating commands to specific hardware, software, or data base management systems. The thesis proposes the EDI concept as a step toward realization of better data distribution and management in WWMCCS ADP.

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I. INTRODUCTION

In the Worldwide Military Command and Control System (WWMCCS) current ADP capabilities do not provide sufficient support for the exchange of data among commands in a timely and effective manner. In order to exchange data today, generally, commands must have the same hardware and software. In some other cases specific software must also be developed to exchange and translate data between applications which are interfaced. These conditions cause inefficient use of resources and severely limit capabilities to respond to command and control requirements.

Evolving requirements including the development of the Joint Operation Planning and Execution System (JOPES) are forcing the WWMCCS ADP community toward the development of a distributed data base approach to information management. In this thesis the Electronic Data Interchange (EDI) concept is examined as a proposed system for realizing a distributed data approach.

> "The U. S. Electronic Data Interchange (EDI) Standards are designed to facilitate the electronic interchange of data in a standard manner between independently organized, owned, and/or operated computer and communication systems. . . The EDI standards grew from needs in transportation and payment applications and have been extended for use in other business and technical applications." [Ref. 1: p. 6]

Implementation of this sort of system would facilitate interfaces among commands while not limiting participating commands to specific hardware, software, or data base management systems.

Chapter II of the thesis provides background by defining WWMCCS, and WWMCCS ADP, and explains the current approach to WWMCCS ADP management. Chapter III discusses the problems of data management in conventional planning and execution. In this chapter specific problems are identified along with documented requiements which cannot be satisfied using the current procedures. Chapter IV, Recommendations, includes some background on current capabilities in ADP which could be explcited for better command and control. In addition the Electronic Data Interchange (EDI) concept is examined as a proposed system fcr meeting evolving WWMCCS ADP data management requirements. EDI is evaluated in its potential to alleviate the specific problems which are identified in Chapter III. Chapter V provides a summary of how the EDI concept could help improve data interchange among commands and includes an illustration of an EDI application.

The thesis propcses the EDI concept as a step toward realization of better data distribution and management in WWMCCS ADP.

II. BACKGROUND

A. WWMCCS ADP OBJECTIVES

"The WWMCCS is the Worldwide Military Command and Control System that provides the means for operational direction and technical administrative support involved in the function of command and control of United States military forces," [Ref. 2]. The elements of WWMCCS are;

- warning systems
- communications
- command facilities
- executive aids
- data collection and processing

The WWMCCS ADP System includes the ADP hardware, system software, application software, data bases, files, procedures, data management system(s), related personnel, data communications equipment, and circuits. The ADP support at the Service headquarters and Service component levels may be a mix of both WWMCCS and unique systems.

> "The WWMCCS ADP system(s) must support both the primary and secondary missions of the WWMCCS as stated in DOD Directive 5100.30 and JCS PUB 19. In doing so, the ADP system will support the command and control requirements of the National Military Command System (NMCS), unified and specified commands, component commands, service headquarters, subordinate unified commands, JTFs, TOAs, the Joint Deployment Agency (JDA), and the Joint Strategic Target Planning Staff (JSTPS), and related functions of other defense agencies. The system must support the decisionmakers and their staffs by providing;
>
> timely and accurate information on the status and location of forces and major resources
>
> the capability to develop and implement both conventional and nuclear operations plans and options

the capability to formulate and transmit direction to and receive and assess reports from the appropriate commands and organizations

the capability to rapidly and securely exchange information, both laterally and vertically, across service and command boundaries...

In general, meeting these objectives will result in a capability to capture, transmit, and process information in a timely and accurate fashion and to display useful and easily understood formats." [Ref. 3: p. A-2]

<u>The WWMCCS ADP Concept of Operations and General Requirements for Post-1985</u> was approved by the JCS and the Services in 1981. The documentation identified four functional families of processing requirements within WWMCCS ADP. Most WWMCCS applications software and data bases can be grouped into one of these functional families:

- Resource and Unit Monitoring (RUM)
- Conventional Planning and Execution (CPE)
- Nuclear Planning and Execution (NPE)
- Tactical Warning/Attack Assessment and Space Defense (TW/AA and SD)

Conventional Planning and Execution will be used to illustrate some of the problems which can result when there is insufficient provision for interfaces among data bases. Conventional Planning and Execution (CPE) generally includes the development, maintenance, and execution of operation plans for the deployment and employment of United States military forces. CPE includes:

- Generating and refining operatonal requirements
- Merging requirements from different plans
- Determining oplan feasibility
- Matching requirements with actual resources
- Developing and disseminating schedules and orders
- Identifying shortfalls and limitations
- Rapidly reflowing movement requirements

- Coordination and monitoring mobilization and deployments
- Aggregating and summarizing requirements

The CPE function relies heavily on ADP support especially since the JCS has directed that the Joint Operational Planning System (JOPS) be used in planning for operations, force deployment, and support of U.S. Joint Military Operations. "The JOPS consolidates policies and procedures for the development, coordination, dissemination, review and approval of joint plans for the conduct of military operations," [Ref. 4: p. 3]. In addition, the members of the Joint Deployment Community (JDC), which includes the unified and specified commands, component commands, Services, TCAs and JDA, use the Joint Deployment System in support of operation plan execution and monitoring. To communicate and coordinate among commands in support of CPE the WWMCCS Intercomputer Network (WIN) is used. Many command and service unique software applications are used to prepare data for input to JOPS and JDS, but interfaces among these unique applications and JOPS and JDS are for the most part manual as is the interface between JOPS and JDS.

B. WWMCCS ADP MANAGEMENT

The management approach which has prevailed in WWMCCS ADP has been one of standardizing software as well as hardware. Management procedures for the WWMCCS standard ADP system are promulgated in JCS PUB 19. The procedures support the acquisition, maintenance, and continued improvement of the WWMCCS standard ADP system and apply to its users. Objectives of these procedures include:

> "reduce the duplication of effort in design, development, acquisition, and maintenance of WWMCCS ADP hardware, application software, and system software,

maximize the benefits of compatibility and standardization of WWMCCS ADP hardware, application software, and system software," [Ref. 5: p. II-14]

C. WWMCCS ADP STANDARD APPLICATIONS SOFTWARE

" Application software or portions thereof, developed within a command, agency or Service or for the Chairman, Joint Chiefs of Staff, will often have applicability to like command-level WWMCCS activities or the other command levels with common requirements or similar information needs... In particular where a Service, agency, or command or the Chairman, Joint Chiefs of Staff, has an existing capability to perform a specific technical support task, that capability will be utilized to the maximum extent feasible rather than initiating a separate development effort." [Ref. 5, p. III-2]

What this means in the WWMCCS ADP community is that an individual command, Service, or agency is assigned as the Designated Responsible Activity (DRA) for development and standardization of a specific application which has been approved as a standard. The OJCS C3 Systems Directorate maintains cognizance over all standard systems in an effort to avoid unnecessary duplication and attempt to meet a broad spectrum of user requirements.

By the late 1980s, this "standard" WWMCCS ADP with its processors and associated software will be technologically obsolete, operationally archaic and difficult to support logistically. (Modernization will require both new hardware and new applications software and system software)." [Ref. 6: p. ES-1]

Much of the standard applications software was written originally to operate in a batch processing environment which makes it inefficient and often ineffective for crisis support which generally requires interactive capability. At present a data base must be resident on the same computer as the executing application. This means that every site using

an application must have access to copies of the relevent software and data base on the system on which the processing will be done. Many commands have modified their copies of the standard applications to better suit their unique requirements so that it is actually no longer the standard application software.

III. PROBLEMS

Conventional Planning: Execution

A. THE CPE ENVIRONMENT

1. Planning

The JCS has directed that the Joint Operation Planning System (JOPS) will be used in planning for operations, force deployment, and support of US joint military operations. JOPS supports planning under time-sensitive or crisis conditions with procedures which form the Crisis Action System (CAS). Under non-crisis, peacetime situations JOPS is employed in the deliberate planning process.

a. Deliberate Planning

Deliberate planning consists of five phases which are outlined in Figure 3.1 [Ref. 4: p. 3]
The major product created during the plan development phase of JOPS is the time-phased force deployment data (TPFDD). When planning is complete, the TPFDD contains all of the information needed to describe a deployment. TPFDD refinement is conducted in a two-phase conference hosted by the Joint Deployment Agency (JDA).

The WIN is utilized as a timely, secure means of distributing data to the deployment community to facilitate the refinement process. Prior to the Phase I refinement conference the WIN is used to distribute the unrefined TPFDD, which contains only notional data, to the deployment community in order that initial analysis can be conducted prior to the conference. During the Phase I conference as actual forces are designated to replace the notional forces in the TPFDD and transportation requirements are identified, the TPFDD is updated to reflect these changes and

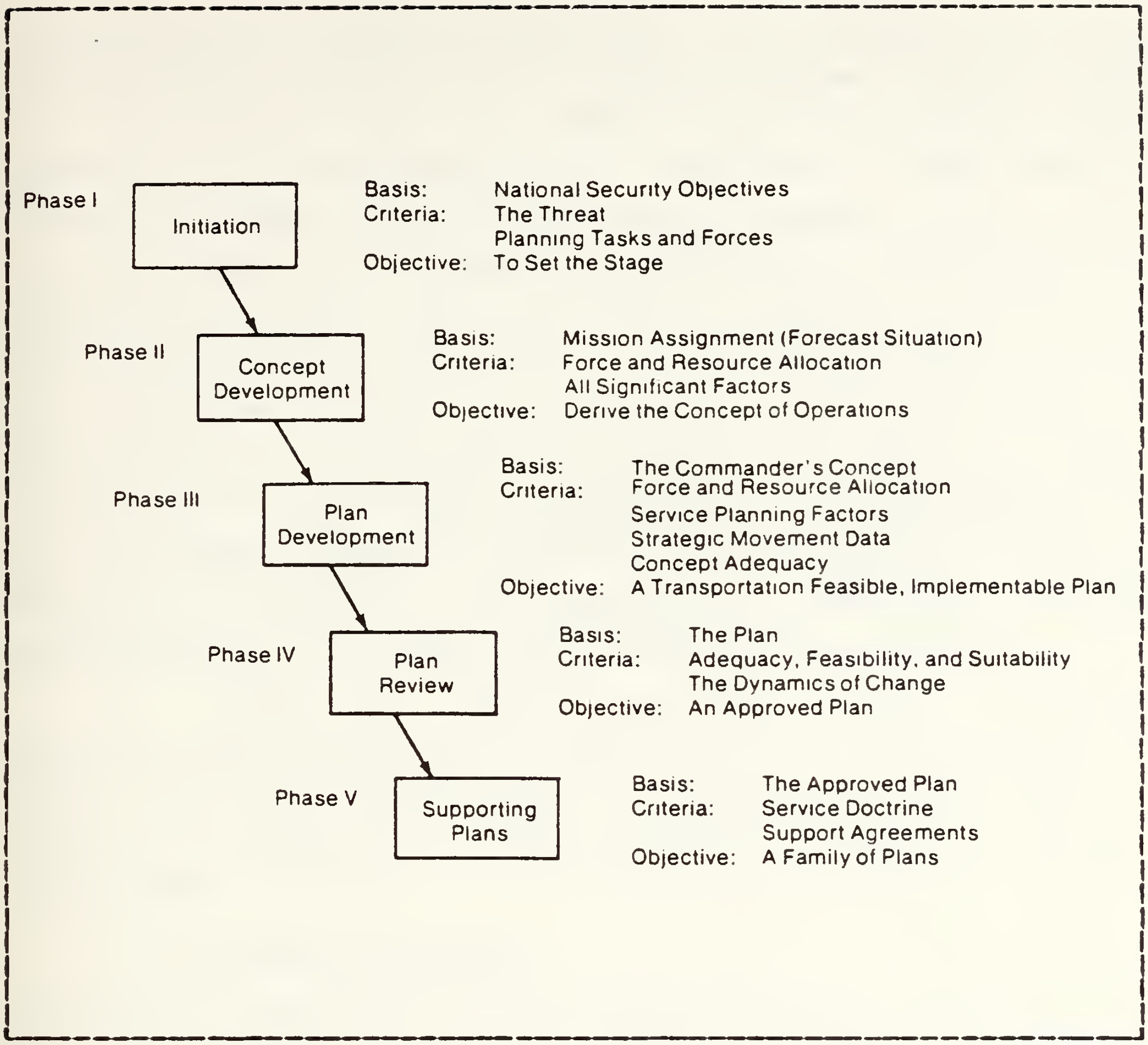

Figure 3.1 Deliberate Planning.

distributed to the TOAs. Each of the TOAs uses command unique applications software to prepare movement schedules supporting the requirements in the TPFDD and to check the resulting schedules for feasibility of execution, identifying shortfalls (requirements which cannot be met). Military Airlift Command (MAC) forwards the TPFDD by WIN to Military Traffic Management Command (MTMC) after identifying airlift in support of the plan and checking the plan for

feasibility. As the provider for ground transportation and transportation within the continental United States, MTMC identifies and tests for feasibility the transportation support to be provided by MTMC. The WIN is used again to forward the TPFDD to Military Sealift Command (MSC). The sealift support for the plan is identified, as well as the resulting shortfalls, and the TPFDD , with air, ground, and sea transportation identified, is forwarded by WIN to the Joint Deployment Agency. In addition, the modified TPFDD is distributed to the deployment community for review of shortfalls prior to the Phase II conference. During Phase II of the refinement process as shortfalls are studied the plan is modified to resolve the shortfalls, resulting in the requirement for reflowing the transportation support.

When the TPFDD has been refined and the resulting OPLAN reviewed and approved by the Joint Chiefs of Staff, it is then entered into the deployment data base at JDA and is accessible to the deployment community by means of the WIN.

b. Plan Maintenance

An ongoing teleconference is maintained for each approved OPLAN in order to provide a forum for discussing changes required to maintain and update the plans.

> Usually the first 15 days of airlift and the first 30 days of sealift are reviewed by the appropriate members of the Joint Deployment Community, who verify that the units and material designated in the plan are actually available, and would most likely be the ones used, should the plan be executed... upon completion of the maintenance cycle, the revised data replaces the outdated requirements in the Joint Deployment System (JDS), [Ref. 7: p. 13].

This review is usually conducted quarterly.

c. Time-sensitive Planning

The Crisis Action System (CAS) which is utilized for time-sensitive planning has six phases as illustrated in Figure 3.2 [Ref. 4: p. 7].

In the situation development phase commanders can use the WIN to submit Operational Reports (OPREPS) to appropriate authorities. OPREP messages are used to communicate concerning incidents or conditions which could evolve into a crisis.

In the crisis assesment phase WIN is used to conduct a teleconference in which representatives from the NMCC, the Service headquarters, the Unified and Specified Commands, the JDA, and the TOAs participate.

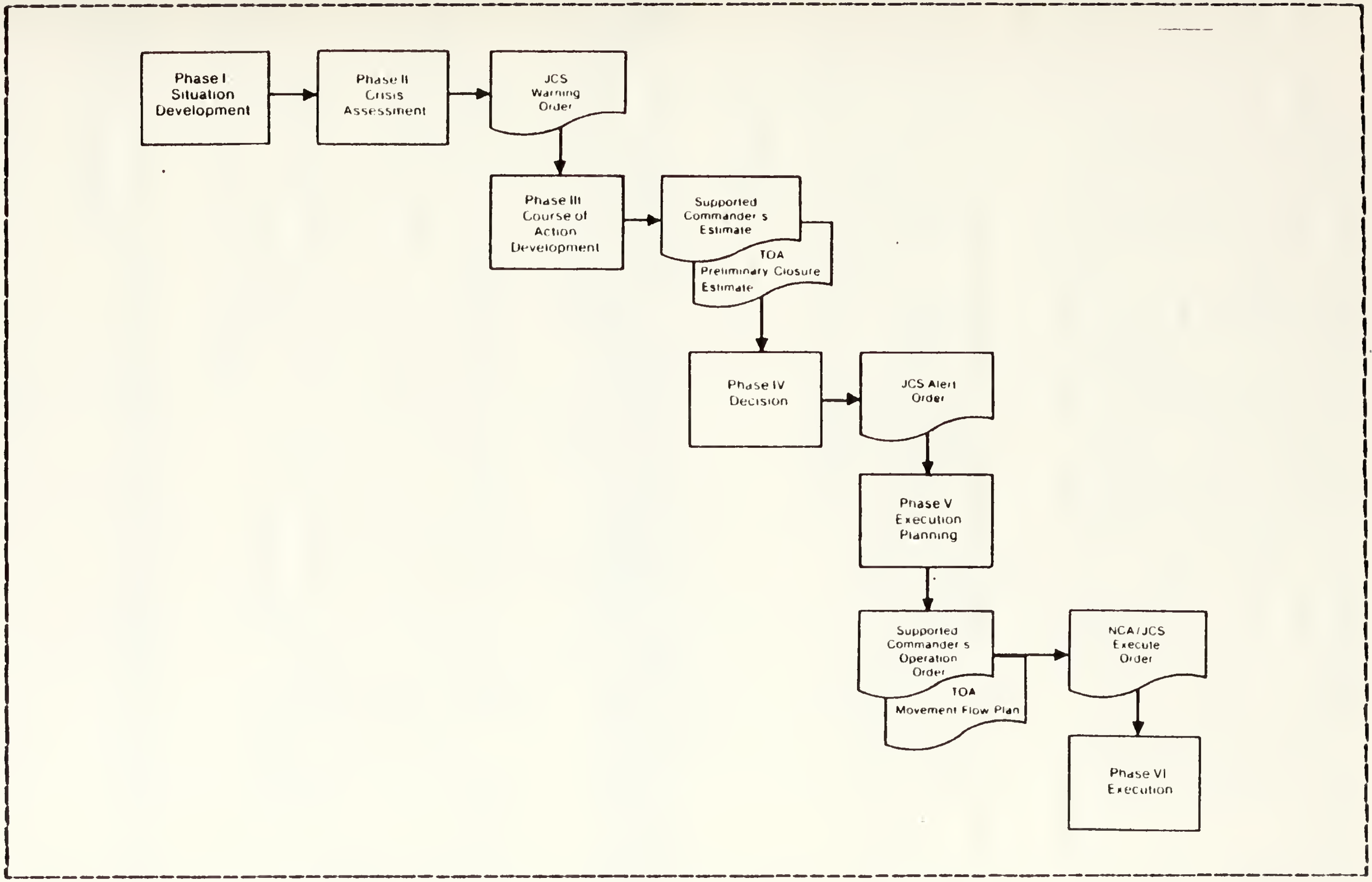

Figure 3.2 Crisis Action System.

In the course of action development phase the WIN is utilized as the transmission mode for the OPREP-1 messages used to exchange required information. Using OPREP messages on the WIN, JCS promulgates a warning order, the supported commander then tasks the deployment community for required assistance in developing or revising plans. The depolyment community in turn forwards responses and the JDA updates the JDS data base for the plan being developed or modified.

In the execution planning phase WIN is used for transmission of the alert order and operation order. The deployment community develops supporting operation orders as required and uses WIN to forward updated information to JDA for inclusion in the JDS data base.

2. Execution

> "The Joint Deployment System supports deployment execution and sustainment of forces...After the JCS execute order, the JDS must monitor status of deploying forces, material, and non-unit related personnel...JDA must also be able to rapidly respond to changes in the deployment as execution processes." [Ref. 7: p. 16]

The JDS capabilities supported by WIN, which are available to the joint deployment community during deployment execution are:

- A teleconference is used to exchange textual information among the members of the deployment community to assist in decision making.

- Access to the JDS data base is available by one of the following means:

-- Direct access to the JDS data base is possible using WIN to access the timesharing subsystem of the JDA host computer. By this means remote users can review or update the JDS data base.

-- Transfer of portions of the JDS data base to remote sites is possible using WIN. Then users at remote sites can run command unique applications programs using their copies of the JDS data base. These copies of the data base will not reflect updates to the data base at JDA unless a later transfer is initiated.

-- Direct access to the JDA data base is possible throught the JDS Remote Users Package (RUP) which permits the user to update a local copy of the JDS data base while simultaneously updating the JDS data base resident on the JDA computer. This permits commands to have access to the most up-to-date version of the JDS data base on a real time basis.

The RUP is considered to be the prefered method for timely transfer of information between JDA and the remote sites since it not only provides the remote user the capability for timely submission of updates and changes but also permits the remote user to recieve changes simultaneoulsly as the JDS data base is updated by other members of the deployment community. In addition the RUP permits the remote user to run command unique applications programs using the local copy of the data base. "As part of the RUP, the JDA has developed communication support software called the JDS Interface Processor which uses existing WIN to support transaction updates between two WIN sites in near real time." [Ref. 7: p. 70].

The JDS also interfaces with MAC and MTMC using WIN to transfer information to and from

- the Integrated Military Airlift Planning System (IMAPS) at Military Airlift Command
- the Mobility Analysis and Planning System (MAPS II) at Military Traffic Management Command.

These automated interfaces facilitate the timely exchange of movement requirements and scheduling information between JDA and the TOAs.

B. SPECIFIC PROBLEMS

Several examples of the kinds of problems which occur in processing in a distributed environment can be found in examining the JDS as part of the WWMCCS ADP support for CPE.

a. Interface Between JOPS and JDS

The JDS is the ADP tool used to manage information in support of deployment and OPLAN execution. In order to properly support its mission the JDS must interface with JOPS which is used to develop oplans. The current interface is, "time-consuming and relies heavily on manual reviews and manipulation of 'data'," [Ref. 8: p. 8]. The JOPS handles notional data, dealing with types of units rather than specific named units. JDS, however, has in its data bases specific named units which will be used in specific plans. In order to obtain the proper information for the JDS data base, manual reviews of the notional JOPS data are conducted and after specific actual units are named in support of requirements, the JDS data base is prepared. In addition, each of the TOAs requires support from command unique software to convert the notional movement tables from JOPS into schedules which use actual named assets. These schedules are then used to provide input for the JDS data base.

The interfaces among these systems are primarily manual at the present time. In addition, although the WIN is used to transfer data between participating commands, each command running JOPS uses its own copy of the TPFDD during processing as well as its own copy of the JOPS software. This results in considerable duplication of files and a resulting requirement for extensive coordination to ensure each site is using copies of the same TPFDD data base in order to prevent decrepancies.

b. NOPLAN Support

"There are no adequate procedures to rapidly establish a deployment data base in a NOPLAN situation," [Ref. 8: p. 11]. Since in the current JDS the only way to review data is in connection with one specific OPLAN at a time, it is difficult to efficiently use data already in the data base in support of a NOPIAN situation. There is not even automated assistance to determine which units are tasked to support more than one OPLAN. This is a deficiency in the current system since there is a validated requirement that, "The JCS will review the supported commander's estimate and approve or modify the recommended course of action after determining the effect on other operation plans and global capabilities," [Ref. 9: p. 12]. There is currently no timely, efficient way for commanders to share NOPIAN information when developing potential courses of action without actually sending copies of data bases or lengthy messages between commands.

c. Data Base Inconsistencies

The primary method for transfer of data among commands using the JDS is the WIN. Recent tests conducted during a major exercise have shown in a fairly small sample of JDS data base records that there are numerous

inconsistencies among copies of the data base at various sites (Joint Deployment Agency, European Command, Military Airlift Command):

"The technique we used to determine the synchronization of JDS data bases was to select a sample of carrier records and determine if the information was the same in each of the three data bases. . .This oplan has thousands of carriers, so we limited our sample to those carriers we knew had been updated--those with Deviation and/or Diversion reports. We retrieved carrier manifest data on forty-five records stored at each of the three locations . . . In summary, this very small sample of carrier records having been modified by deviation/diversion reports, had a high percentage of differences between RUP and JDS data bases." [Ref. 10]

The data shown furnishes examples of the discrepancies found: [Ref. 10]

CARRIER A03895	SCH ARR
EUCCM	255426ZFEB AT BRUSSELS
JDA	250000OFEB AT BRUSSELS

Discrepancy: a difference in scheduled arrival time

CARRIER A04526	SCH DEP	
EUCOM	CITY OF COLORADO SPRINGS	(TDHV)
JDA	PETERSON FIELD	(TDHV)

Discrepancy: a difference in the name associated with a specific location code

CARRIER A04021	SCH ARR
EUCCM	251626ZFEB
JDA	250000OFEB

Discrepancy: a difference in the scheduled arrival time

CARRIER A04182	SCH ARR	CARRIER DEVIATION
EUCCM	261651ZFEB	---

JDA	260000OFEB	DELAYED 2 HOURS DUE TO DEMONSTRATION AT APOD

Discrepancy: a difference in the scheduled arrival time and a note concerning carrier deviation which only shows at one site

The need for complete, accurate, timely information is often taken for granted. In the CPE environment this requirement is even more challenging since all participating commands need to be working with identically updated data bases if they are to make valid assumptions for planning and executing oplans.

d. Data Base Management

"There is also a requirement to develop a system to restrict access to data and restrict the capability to change data elements within JDS," [Ref. 11: p. 2-10]. Safeguards to prevent unathorized changes to data elements in the JDS are insufficient. An authorized JDS user with modify permissions may make unauthorized modifications in the data base since individual types of changes or types of data elements are insufficiently safeguarded.

A change or update to the JDS data base using one update module may or may not update relevent corresponding data elements. For example, if a carrier is reported as sunk using one update module a query module to display ships arriving on a given date may still display the ship as scheduled to arrive.

"A major problem facing the deployment community is the lack of standardization of data elements between the JOPS, JDS, UNITREP, and OPREP. Because of the need to accomodate the interface with these systems, JDA has been forced to pick and choose between various data elements,

definitions and formats," [Ref. 11: p. 3-8]. The following are some of the problems resulting from the attempt to interface these systems:

- data elements which actually have the same meaning have different names (e.g. different versions of an airfield name associated with the same location code)

- data elements which have the same meaning may have different units or be calculated using different algorithms (e.g. weight reflected in long tons on one system and short tons on another)

- data elements which have different meanings have the same names (e.g. arrival date on one system may be the time a unit will arrive in theatre, on another system it may be the time a unit will arrive at port of debarkation)

As the data base structure or the basic software of the JDS changes, the command unique queries written to run against the JDS data base must also be changed.

C. REQUIREMENTS

In July 1983 the Joint Chiefs of Staff approved the Joint Operation Planning and Execution System (JOPES) Required Operational Capability. The initial operational concept,

> "Addressed procedures supported by state-of-the-art ADP capabilities which would result in producing capability-constrained courses of action in a matter of hours and completed plans, fully sourced with actual units tested against deployment and sustainment capabilities, within days. These criteria, once achieved, represent a revolutionary improvement to present planning system capabilities." [Ref. 9].

JOPES is envisioned as, "The foundation for our conventional command and control system," and will accomplish its functions, "through the interoperation of a central core of joint applications and various C2 and functional systems . . . JOPES must support the planning and execution of multi-theater scenarios involving total commitment of U.S. and Allied forces," [Ref. 12].

JOPES will effectively replace the JOPS and JDS which today support CPE. JOPS and JDS are two separate systems which do not have an automated interface. JOPS is used for planning and JDS for execution. In JOPES, software supporting these functions would not require the manual interfaces required today. In addition, JOPES will be required to share data with command unique applications which support CPE.

> "JOPES consists of the policy, procedures, software, hardware, personnel training, and connectivity necessary to facilitate planning directing coordinating, monitoring and controlling military operations." [Ref. 9: p. 2]

For JOPES to work effectively the WWMCCS community will have to develop and support a distributed data base concept which will permit interfacing command unique software and system standard software. In a distributed data base, portions of the data are stored on different computers. The physical location of the data ideally does not affect processing and is usually not even apparent to the user. This would eliminate the need for synchronizing multiple copies of data bases (except those required for redundancy). Such an environment would also eliminate the manual manipulation of data currently required in interfacing the existing systems which support CPE.

IV. RECOMMENDATIONS

A. CHANGING ENVIRONMENT

The current state of the art in automatic data processing offers many management and technical opportunities to facilitate the transition from the WWMCCS Standard ADP of today to the kind of system required to support the evolving needs of the CPE environment. The requirement to share data among commands in support of CPE requires additional techniques and facilities not required by a single site operating in isolation. The Open System Interface reference model proposed by the International Standards Organization provides a means to describe and document the interfaces required in a computer networking environment. The capabilities provided by local area networking offer the facility to link internal command resources together in support of command unique requirements. The WWMCCS Information System is the onging program to modernize WWMCCS ADP utilizing modern technology to meet evolving requirements.

1. Open System Interface Reference Standard

The International Standards Organization (ISO) proposed the Open System Interface (OSI) Reference Model to serve as a standard set of network interfaces and protocols. The use of the OSI Reference Model would be a step toward international standardization of the various protocols for distributed processing networks. Compatibility among network nodes would be assured by compliance with standards even when software and hardware at various sites are supplied by different vendors.

The OSI standard is based on a seven layer concept. Each layer provides a portion of the services required to interface nodes in the network. By breaking the interface problem into seven layers, the implementation of different portions of the interface can be developed, tested, fielded, and modified independently. The layered approach helps to isolate the functional requirement from the engineering implementation. As more efficient technology becomes available the implementation of a specific portion of the interface can be changed without undue influence on the users' interaction with the overall information network.

The bottom three layers of the OSI model are host to imp protocols and the top four layers are host to host protocols. Only the top two layers deal with interfacing user applications and data.

LAYER 1: The Physical Layer supports the actual communication connection between hosts and the transmission of raw data over the established channel.

LAYER 2: The Data Link Layer ensures data received is error free and the appropriate acknowledgements are sent.

LAYER 3: The Network Layer, sometimes called the communication subnet layer, is responsible for point to point routing of data between its origin and destination.

LAYER 4: The Transport layer, also called the Host-Host layer, is concerned with dividing the data into packets for transmission.

LAYER 5: The Session Layer provides the capability for users of different machines to establish a connection between processes on the machines.

LAYER 6: The Presentation Layer manages the exchange of data between applications anywhere on the network. It ensures the data is in appropriate format for the application to which it is being sent.

LAYER 7: The Application Layer provides the interfaces between user and application and the user and the system.

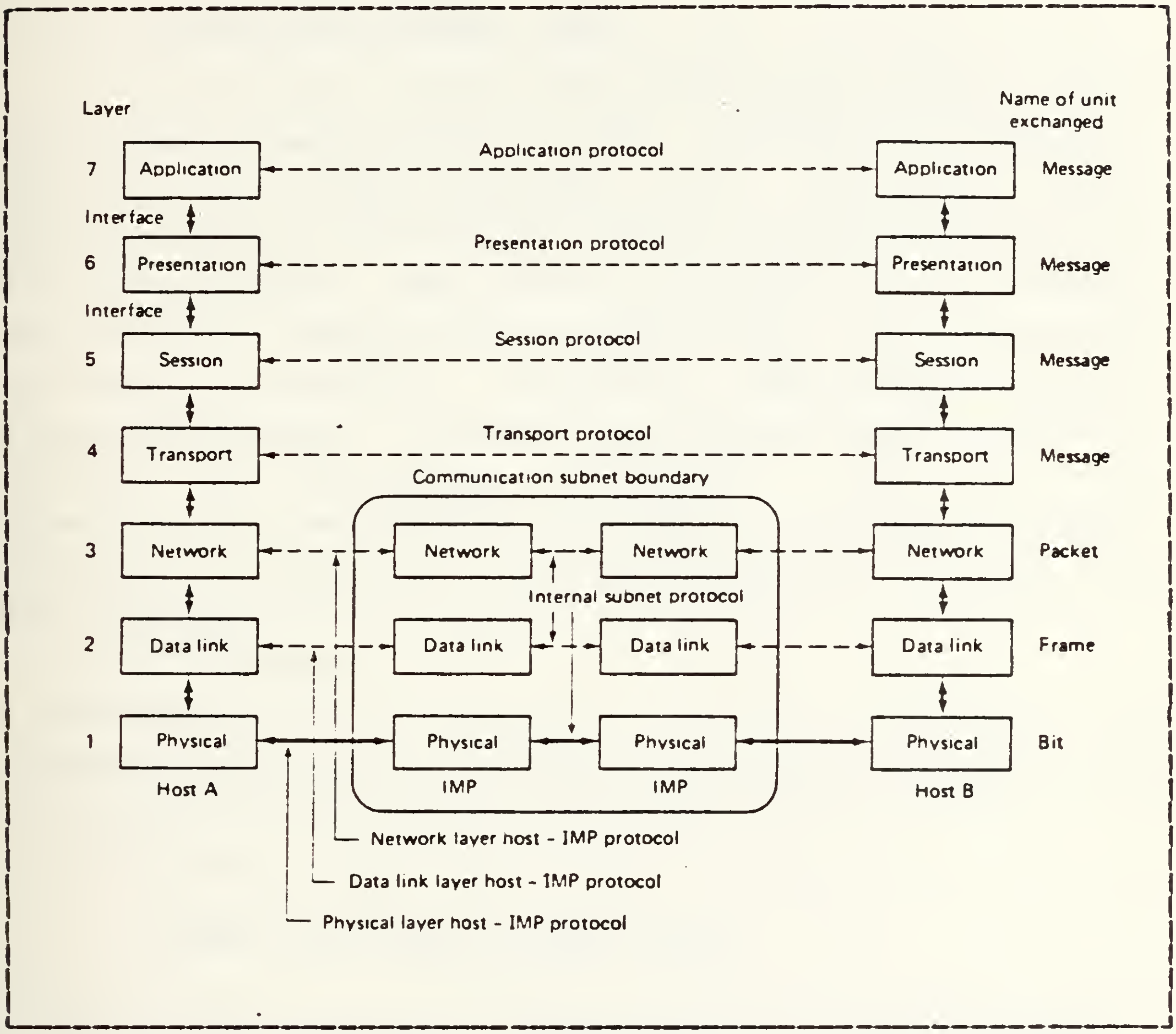

Figure 4.1 Network Based on ISO OSI Reference Model.

Figure 4.1 [Ref. 13: p. 16], illustrates a network based on the ISO OSI Reference Model. The dotted lines represent virtual connectivity between similar layers on different hosts while the solid lines represent physical connectivity. The ISO OSI provides a useful way of describing protocols which perform required network functions while leaving the engineering of the implementation up to the network designers.

2. Local Area Networks (LAN)

Local area networks (LAN) are networks which provide high speed communications among information processing equipment in a limited geographic area. Local area networks have evolved from previously existing methods of networking and communicating. They provide the capability to interface many kinds of devices and to exchange data with other LANs or long haul networks. In general, LANs offer high data transmission speed at lowered costs while sacrificing long distance data transmission capability. LANs are a key element in the strategy for the WWMCCS Information System. Attributes of LANs which are being evaluated for support of WIS include:

flexible topology
security
expandability
flexibility in selecting transmission media
reliability.

3. WWMCCS Information System (WIS)

"The WWMCCS Information System (WIS) encompasses the information collection, processing, and display system that includes WWMCCS ADP and related software systems, procedures and supporting telecommunications. The modernization focus is on the backbone of standard WWMCCS ADP which supports command systems . . . The JPM (Joint Program Manager) focus will be on software and data management techniques." [Ref. 14: p. ES-1]

The WIS is explained briefly in order to shed some light on the current effort to improve WWMCCS ADP which will affect the ADP environment in which CPE users operate. The support provided by WIS will be implemented incrementally thereby providing evolutionary modernization. This will help minimize the overall impact on command and control users while permitting advances in computer technology to be utilized.

> "The WIS JPM task is to modernize and enhance the command control software, acquire state-of-the-art hardware and add capabilities to the command control process. These capabilities include automating the handling of operational messages, distributing data and enhancing the capability of command control personnel to interact with their information." [Ref. 15: p. 17]

Figure 4.2 [Ref. 16], illustrates the capabilities to be provided by WIS. In implementing WIS one goal is to maintain the separation of the the engineering implementation from the desired capabilities. In other words, various commands may use different hardware and software to support their sites. In addition, LANs will provide tailored support for internal requirements of commands while still permitting and interface with the long haul network.

4. Summary

The recurring emphasis in state-of-the-art ADP technology is interfaces which permit the separation of engineering and function. This should permit the users to select the implementation best suited to their needs and still interact with other users supported by different implementations. This conceptually permits systems to continue to grow and evolve, making use of new technology without disrupting the supported functions.

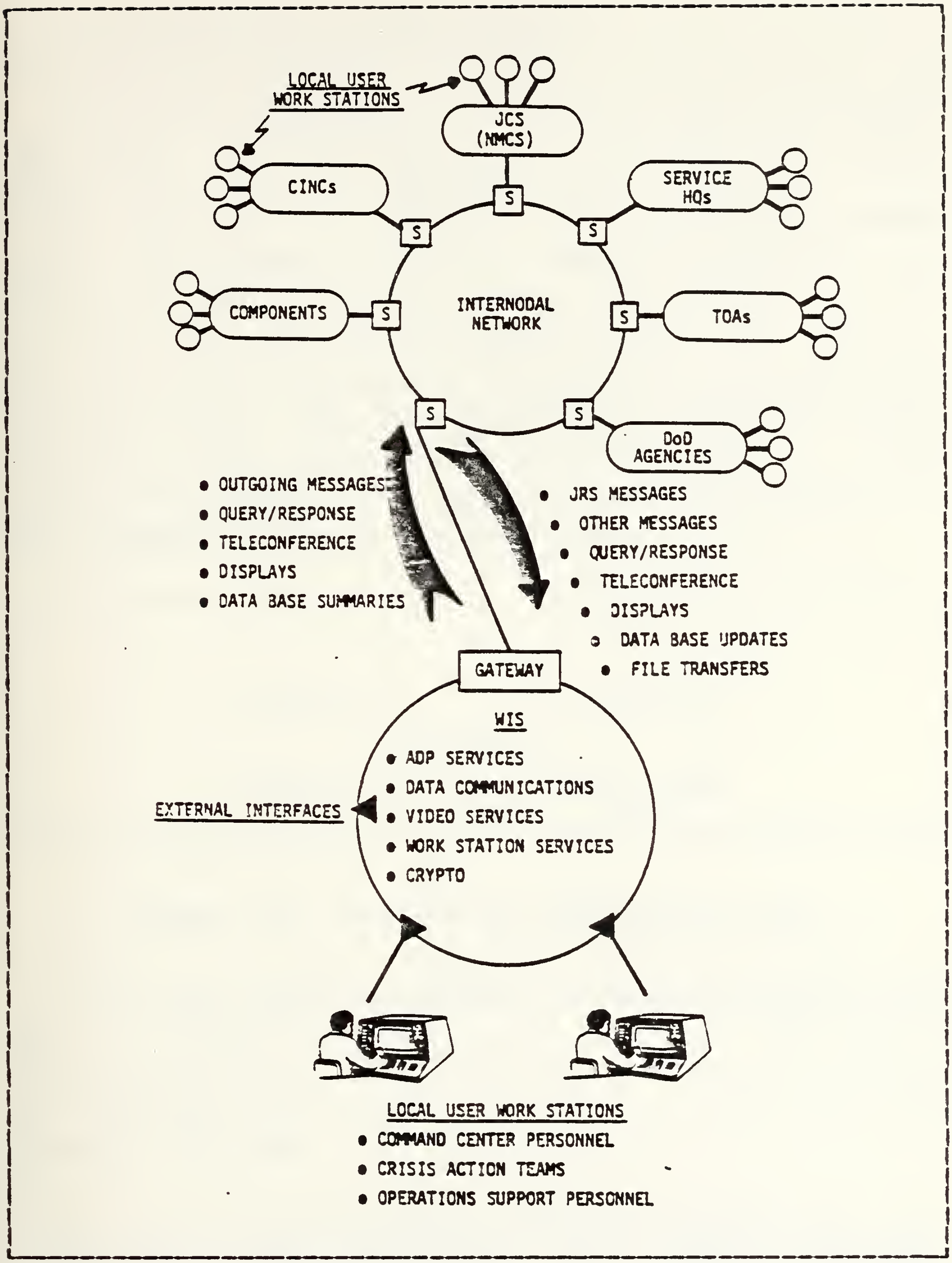

Figure 4.2 User Capabilities Supported by WIS.

E. STANDARDIZATION - A NEW APPROACH

The growing requirement for automated interfaces between the programs and data bases used by different commands to support CPE cannot be supported using the current WWMCCS Standard Software. If commands want to interface software today, the interfaces must be designed individually and uniquely tailored to the two ends of the interface. Figure 4.3 illustrates the interfaces which would be required to link the software of four members of the joint deployment community today. Each line represents a specific interface developed between applications at two commands. In this example six programs are required to interface each of the four commands to each of the other three.

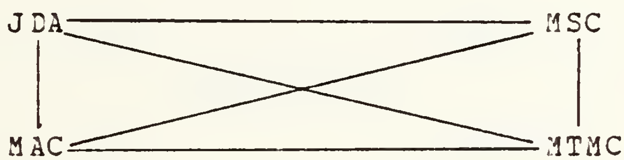

Figure 4.3 Interfacing under WWMCCS Today.

It is clear that in addition to necessitating many man-years of software development, an interface would require updating each time an application on one end was modified. The requirement still exists, however, to share data among commands. In JOPES,

"Once an originating agency updates its data base, the distributed data base concept will permit automatic updating, in summary format, of all interrelated data bases . . . JOPES will not burden lower level staffs with extensive reporting requirements but will interface with command and agency-unique systems as necessary and within owner specified limits to rapidly obtain information." [Ref. 9]

JDA has made progress with near real-time updating of data bases located at different commands but the JDS requires all participating commands to be using exactly the same JDS software, operating on the same WWMCCS Standard Hardware. This approach does not permit the interfacing of command unique applications and data bases among commands.

In order to obtain the benefits of timeliness and accuracy in interfaces, an ADP solution is preferable to the current manual interfaces. If the WWMCCS community would define a core set of data which is required for CPE and standardize the description of this data, each command seeking to interface with another command would only have to develop an interface between the standard data set and their command unique software. Figure 4.4 illustrates the Joint Deployment Community interfacing in this manner.

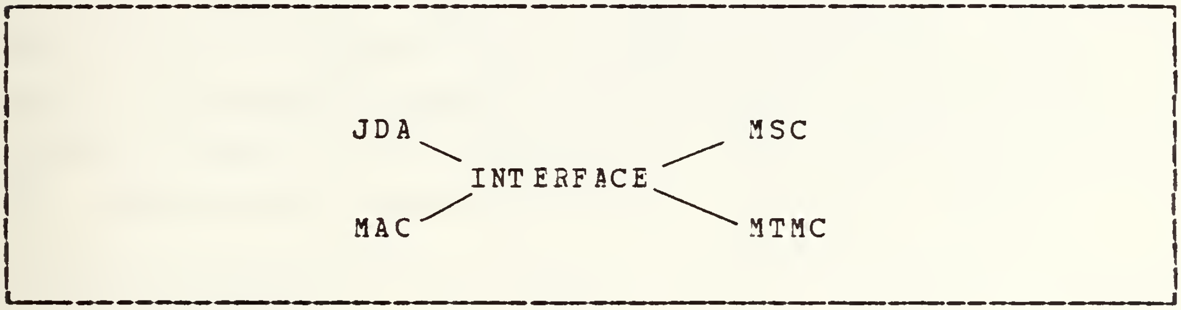

Figure 4.4 Interfacing through a Standard Data Set.

The total number of interfaces would be reduced significantly and each command would only have to plan one interface with the standard data set in order to interface an application with all other participating commands. In this example the total number of interfaces was reduced from six to four by interfacing through a standard data set. More important, each node now only requires one interface vice the three previously required. The use of a common

interface permits many widely separated data bases to function virtually as a distributed data base. This will help meet the identified requirement for a distributed data base approach to support JOPES. It is not a distributed data base in the routine sense but rather an interface which permits the exchange of data among separate data bases. This concept is further developed in a later section.

1. Electronic Data Interchange (EDI)

a. Background

"The U.S. Electronic Data Interchange (EDI) Standards are designed to facilitate the electronic interchange of data in a standard manner between independently organized, owned and/or operated computer and communications systems," [Ref. 17: p. 9]. The EDI standards were developed in an extensive joint government-industry effort to meet a recognized need in the transportation industry for timely, reliable transmission of data among organizations. The organizations utilizing the EDI standards include:

Motor Carriers
Ocean Carriers
Air Carriers
Railroads
Brokers
Shippers
Consignees
Freight Forwarders
Freight Consolidators
Banks
Agents
U.S. Customs Service
U.S. Department of Agriculture
U.S. General Services Administration
U.S. Department of Defense.

b. Structure of EDI

The major unit of information in EDI is the transaction set. Transaction sets support the major functions performed by the communicating organizations. Information units in the EDI include:

"Data Element: The smallest information unit in the EDI information structure is the data element. A data element may be a single character code, a series of characters constituting a literal description, or a numerical quantity.

Data Segment: A data segment is composed of a function identifier and one or more functionally related data elements positioned serially in a standard manner . . .A segment is roughly equivalent to a line of information on a bill of lading or freight bill.

Transaction Set: A transaction set is a group of data segments, in a predfined sequence, needed to provide all of the data required to define a complete transaction such a s shipment information or invoice . The transaction set in EDI equates to a document in a paperwork system, such as a bill of lading or invoice.

Functional Group of Transaction Sets: A functional group identifies those transaction sets of the same type (having the same indentifier and subject title)." [Ref. 18]

Figure 4.5 [Ref. 19], shows how the information units are put together to build a complete transaction set. The first data segment shown in the second column of the example is composed of the first four data elements in the first column. This same data segment becomes the first part of the transaction set in column three. It should be noted that a data element (e.g. A) can be used in more than one data segment.

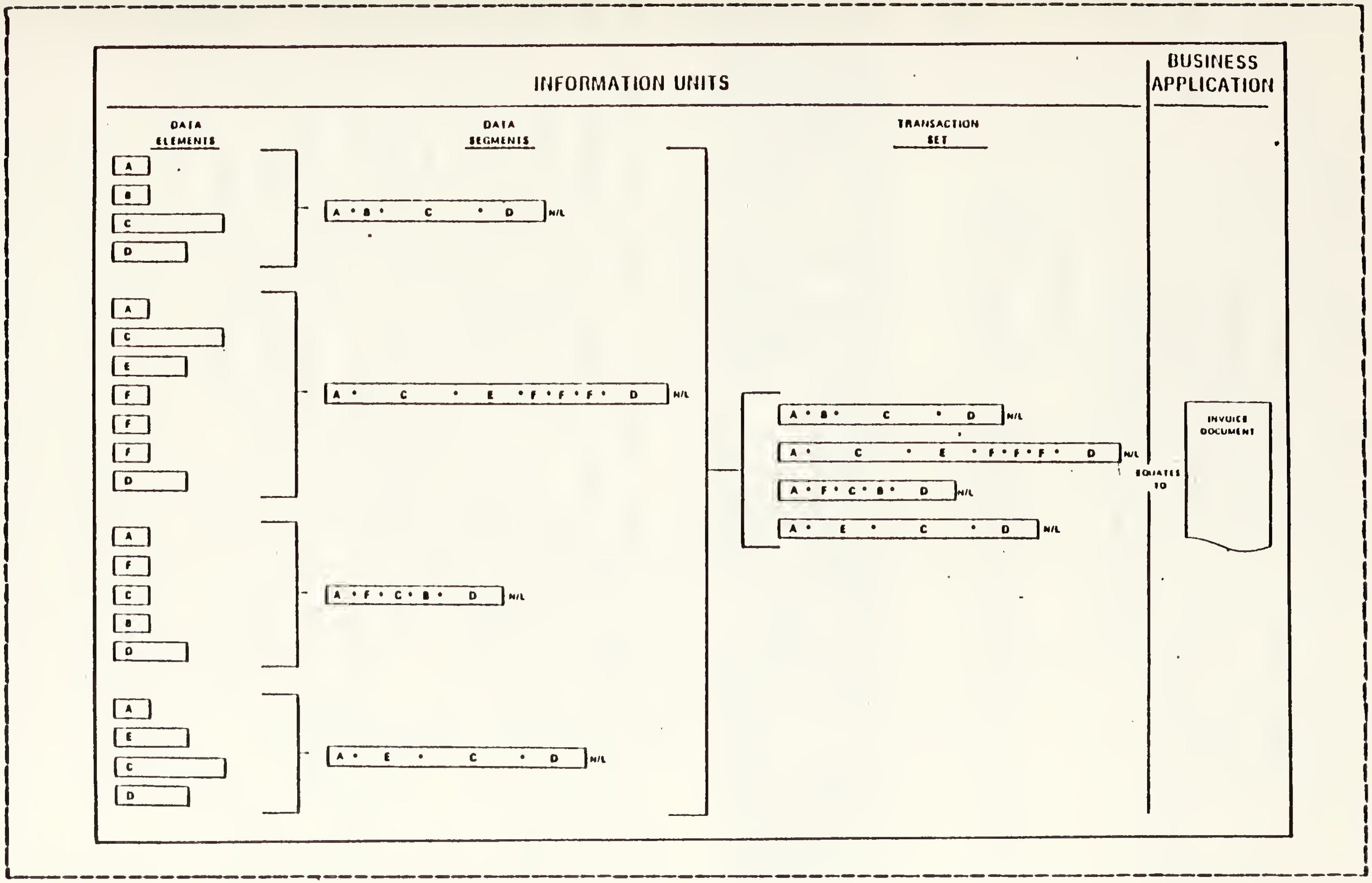

Figure 4.5 The Structure of a Transaction Set.

Figure 4.6 [Ref. 19], shows how a communications session with a user inputting data into the network can include more than one transaction set. This figure follows the building block approach by showing that related transaction sets (e.g. purchase orders) can be regarded as a functional group and several related or unrelated functional groups can be sent in the same transmission.

c. EDI Operations

The EDI concept operates through the use of five tables.

> "The same five tables are used for generation of data to be transmitted and for the interpretation of data that is received. The set of tables defines the structure and attributes of the EDI transaction sets, segments, data elements, and codes. The EDI operational software programs control pointers to these tables and use the information at the pointer locations, in combination with data from the user's data base, to assure program generation and interpretation of data." [Ref. 19]

These tables are used to process incoming and outgoing data. Figure 4.7 [Ref. 19], explains generally how the tables are used. Figure 4.8 [Ref. 19], presents a more detailed example of the data structure, with sample entries for each table described in figure 4.7 Table 1 has a list of all transaction sets with identifying numbers. Table 2 lists the data segments in each transaction set. Table 3 is a directiory of all data segments with identifying numbers. Table 4 lists the data elements in each data segment. Table 5 is the data dictionary and is broken down by data elements. Detailed examples of each table are given in a later section..

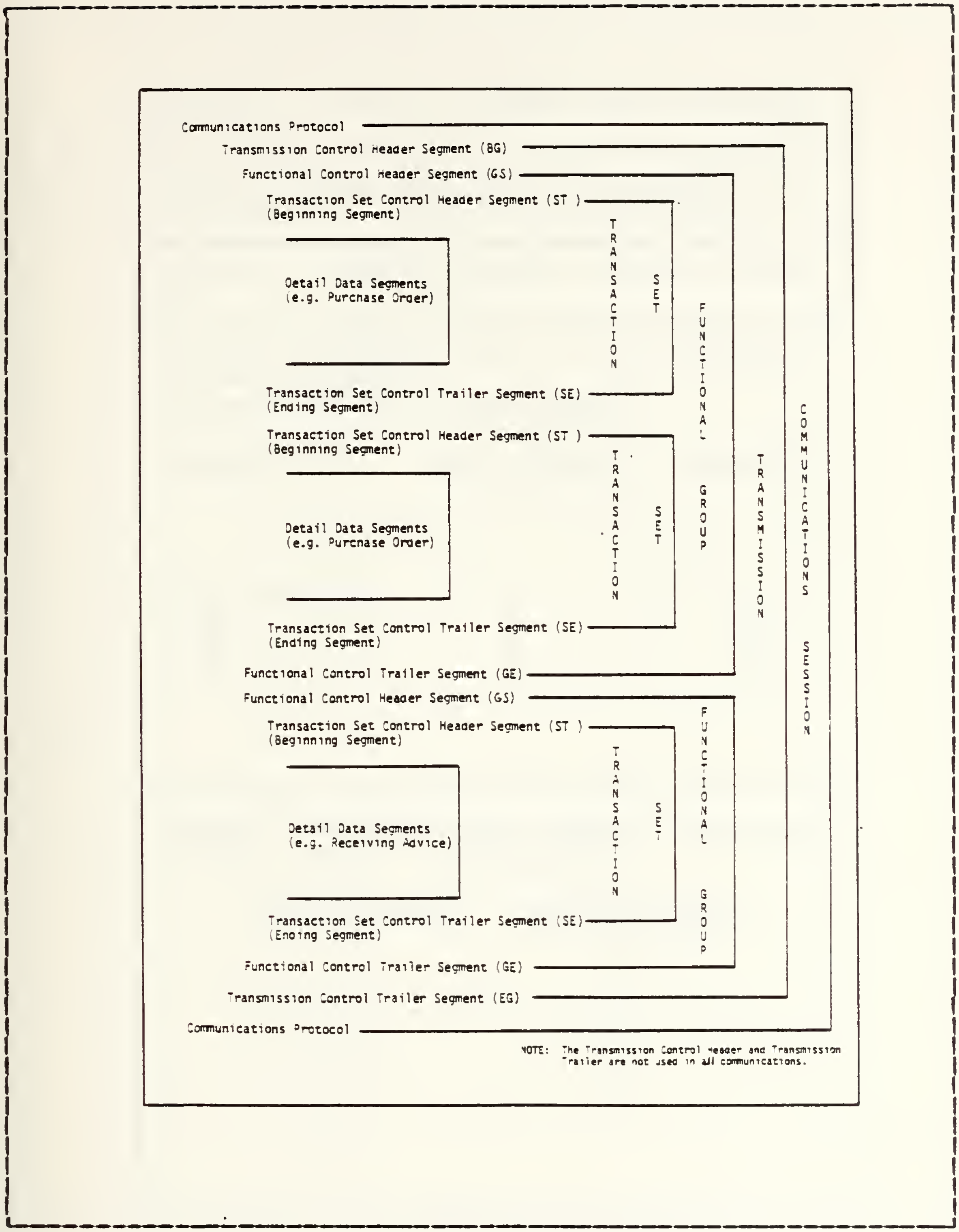

Figure 4.6 A Communications Session.

Table 1 is used to locate items in Table 2.

Table 2 gives the order of segments in a transaction set for each application.

Table 3 is used to locate items in Table 4.

Table 4 gives the order of data elements in each segment.
Table 4 example (simplified):

Segment I.D.	Data Element	Location
.		
.		
.		
EX (Example)	D	11
EX	A	1
EX	E	13
EX	C	9
.		
.		
.		

Table 5 specifies data element attributes.
Table 5 example (simplified):

Data Element	Maximum Length
A	4
B	4
C	2
D	2
E	12
F	8
.	
.	
.	

Figure 4.7 Use of Tables in EDI.

TABLE 1 - TRANSACTION SET NAMES

SET NAME	SET I.D.	SEGMENTS (TABLE 2)
⋮		
SHIPMENT INFORMATION (OCEAN)	304	39
⋮		

TABLE 2 - SEGMENTS IN TRANSACTION SET

SET I.D.	SEGMENT I.D.	REQUIRE-MENT	MAXIMUM USE	SPECIAL PROCESS#	LOOP CONTROL	LOOP INDEX
⋮						
304	B2	M	1	0	0	0
304	Y6	C	2	0	0	0
304	G1	C	1	0	0	0
304	G2	C	1	0	0	0
304	G3	C	1	0	0	0
304	N9	C	15	0	0	0
304	V1	C	1	0	0	0
304	V3	D	1	0	0	0
304	M0	C	1	0	0	0
304	M1	C	1	0	0	0
304	M2	C	1	0	0	0
304	C2	C	1	0	0	0
304	C3	C	1	0	0	0
304	N1	M	1	0	3041	10
304	N2	C	1	0	3041	0
304	N3	C	2	0	3041	0
304	N4	C	1	0	3041	0
...						
304	SE	M	1	UP,16	0	0
⋮						

TABLE 3 - SEGMENT NAMES

SEGMENT NAME	SEGMENT I.D.	DATA ELEMENTS (TABLE 4)
⋮		
AUTHENTICATION	Y6	3
⋮		

TABLE 4 - DATA ELEMENT IN SEGMENT

SEGMENT I.D.	DATA ELEMENT	REQUIRE-MENT	SPECIAL PROCESS	LOCATION IN MASTER RECORD
⋮				
Y6	313	O	0	--> 23<--
Y6	151	M	0	--> 25<--
Y6	275	M	0	--> 208<--
⋮				

TABLE 5 - DATA ELEMENTS

DATA ELEMENT NAME	DATA ELEMENT	MIN. CHAR	MAX. CHAR	DATA TYPE	SPECIAL PROCESS
...					
AUTHORITY	AUTH 151	1	20	M	0
...					
AUTHORIZATION DATE	AUTH-DTE275	6	6	N	DTE, G(20)
...					
AUTHORITY IDENTIFIER	AUTH-ID 313	2	2	A	0
...					

Figure 4.8 EDI Tables - Sample Entries.

d. Advantages of EDI

The emphasis in the EDI concept is on communications (exchange of information) between computers. By communicating through the use of standard transaction sets, EDI permits users to interface efficiently while preserving their autonomy. Each user could conceivably be using different kinds of hardware, software, and data base management systems and still be able to communicate. An added benefit of the EDI approach is that data elements can be added or deleted without requiring software logic changes. Also, changes in a user's applications will not affect the interface with other users as long as the translation to the EDI standard is updated within the command.

The EDI concept could be used within the WWMCCS community to ease the transition to the distributed data base environment which will be required to support CPE. To implement this approach, members of the WWMCCS community would have to define the applications and the data which are required to support CPE. Standard methods for data control would be required. Once the standards were developed and documented it would be the responsibility of each command to make the translation between their applications and the standard. Once all the involved commands are able to translate between their applications and the standard, they could also communicate directly with other participating commands.

2. Application to Specific Problems

The desirability of implementing the EDI concept within the WWMCCS community can be evaluated by examining how it would help resolve the some of the problems which have been identified in WWMCCS ADP support of CPE.

a. Data Base Management

In order to ensure the accuracy of data the capability to modify or delete data must be controlled. The current system does not protect against unauthorized changes made by a user who is authorized access to some but not neccessarily all data. The EDI concept would contribute to security because the data elements would be distributed among the commands with ultimate control and modify permissions held by the command "owning" the data and responsible for its accuracy. Another command could request, data but the system would check to validate the identity of the sender, in accordance with pre-arranged agreements,

> "The communications protocol provides a means for positive identification of the sender by the receiver, and conversely . . . Processing of transmissions which do not pass the commnmunication header validation tests is aborted after an error reply is sent to the sender and the conditions have been logged for subsequent study or analysis." [Ref. 17]

By distributing the data and controlling communications access to specific data, the EDI concept provides more secutity than the current system.

In the current system a change or update to the JDS data base using one update application may or may not update relevent corresponding data elements. Using the EDI approach, many applications could rely on a single copy of a data element so the opportunity for discrepancies would be minimized. Today different applications use different files and it is difficult to effectively update all instances of a data element. In addition, through use of the transaction sets, groups of related data elements could be updated together.

The current lack of standardization of data elements among standard and command unique systems can be significantly reduced through the use of the EDI concept. Initially an effort would be required to identify data elements which must be shared among members of the WWMCCS community. The definitions of these data elements would be specified and incorporated into a standard. Each command which needs to interface with another in the community would then develop the necessary software to translate command data elements into the standard format. "The interface computer program and the structure of each type of transaction set are part of the EDI standards. EDI does not address a standard which extends into a company's internal system," [Ref. 17]. The EDI software would perform the functions which would facilitate interfaces among participating commands. Once data to be interchanged has been defined in a standard definition, individual commands can convert data elements to the standard through individual software routines. This would resolve the following kinds of discrepancies:

- data elements which actually have the same meaning have different names

- data elements which have the same meaning may have different units or be calculated using different algorithms

- data elements which have different meanings have the same names

As the data base structure or the basic software of the JDS changes, the command unique queries which rely on the JDS data base often must be rewritten. The EDI concept is designed,

"To respond with ease to frequent requirements for modification, contraction, and/or expansion of the

individual applications. . . the information is structured so that it may be constructed by one computer system and interpreted and processed by another, New applications and information units may be specified without impacting work previously completed." [Ref. 17: pp. 6-13]

The physical implementation (e.g. the programming languages and the data base management system) of any standard or unique application is kept isolated from the standard data definitions so modifications to implementation methodology will not destabilize the system.

b. Data Base Inconsistencies

The problem of different sites having different copies of the data base would be avoided through the EDI concept because of the distribution of data. Each data element would reside at the command responsible for its accuracy but would be accessible to other commands. Even with provision for redundancy this is still a more desirable arrangement than multiple copies of data bases residing on many systems at many locations. In this way, as data is updated for one purpose (e.g. UNITREP) the updated data would also be available for other applications such as JCPS or JDS without requiring separate updates for each application.

c. NOPLAN Support

The use of the EDI concept could help in a NOPLAN situation by eliminating the necessity to send copies of entire data bases or lengthy messages among commands. As each command successively develops a portion of the plan, data can be extracted from applicable data bases, incorporated into transaction sets and transmitted to other involved commands. Because the construction of new instances of a transaction set can be facilitated by the EDI

tables it would be much easier for commanders to evaluate various alternatives since less data would have to be sent among commands to generate responses to "what if " questions. It would also be possible to include as part of the information on a specific unit the various OPLANs in which the unit was tasked. This could be done by developing a data segment which includes as data elements the unit designation and the plans which task it. In this way potential problems with multi-tasking could be identified quickly.

d. The Interface Between JOPS and JDS

The interface between JOPS and JDS, and other standard or command unique applications could be significantly simplified through the EDI CONCEPT. Since incompatibility of data elements is not a problem when the common interface is used, data from numerous systems could be tapped in response to information queries input using any one of the systems.

C. IMPLEMENTATION

Although the EDI concept requires a standard set of data elements in order to operate, there is no centralized standard data base. EDI facilitates the transfer of data among various data bases by means of a common interface. Laying the groundwork for an EDI interface is in some ways, however, similar to data base design. It will be helpful to examine the necessary preparation for implementing EDI in data base design terms.

A data base is a model of an organization which exists in the real world. Events which occur in the real world are reported to the data base system as transactions which in turn cause data to be modified. Design considerations for data bases as models are listed in figure 4.9 [Ref. 20: p. 177].

Database as a model of an enterprise

Level of detail

Cost of aggregation and generalization is unanswerable question

Need to aggregate and generalize in light of requirements and financial resources

Dynamics of database as model

Enterprise changes, model must change

Events occur, are represented by transactions

Level of transaction important - transactions cannot be more aggregated or generalized than database data

User views

Different perception of data structure

Different perception of data meaning

Need for standardized meaning

Figure 4.9 Design Considerations for Databases as Models.

The fact that in CPE users represent many commands with different views can cause a design problem,

> "Different users (and designers) will have different meanings and interpretations for data that is stored in the database. Questions that appear to be similar may in fact be different." [Ref. 20: p. 177]

Definition of a set of data elements which must be available in an EDI interface would require a great deal of effort with high level support in the joint arena. The standard data elements will be the building blocks from which interfaces will be constructed.

> 'Data base design is divided into two phases: logical design, where the needs of people are specified, and physical design, where the logical design is mapped into

the constraints of particular program and hardware products," [Ref. 20: p. 177].

The logical data base design is done by the users who need to use the data. The physical data base design is normally done by experts skilled in evaluating hardware and software capabilities and selecting the most feasible means of implementing the logical design, This division of effort would apply also in a general way to designing a standard EDI interface, although it is not a data base management system per se.

1. Logical Data Base Design

a. The Output

The output of a logical data base design is a schema which defines the data records (in EDI terminology, the data segments) which are to be maintained, the data elements which compose them, and the relationships among these data segments and data elements. Data segments are described by listing the data elements which they contain and constraints which limit the values the data can have. Transaction sets, in turn, are described by listing the data segments they contain and applicable constraints.

b. Input

The inputs of the logical data base design are the system requirements and the plan which describes the environment and constraints, which will affect the system.

c. Procedures

"The major steps in the logical design process:

- identify data to be stored
- consolidate and clarify data names
- develop the logical schema
- define processing
- review design," [Ref. 20: p. 181].

In the process of identifying the data to be stored, the data dictionary is developed and data elements are identified by name and described. Figure 4.10 [Ref. 18], is an example of a portion of an EDI data dictionary. To see how the data dictionary is set up, consider data element "10" in the left column. Data element "10" is defined as a six digit numeric field which is entered with the first two digits representing the last two digits of the year, the middle two digits representing the month, and the last two digits representing the day of the month. This physical description of the data element is also accompanied by a verbal definition of the data element.

To consolidate and clarify data names it is necessary to identify synonyms and aliases. Synonyms are different names for the same data element. Synonyms should be reduced to one standard name. Aliases are alternate names for the same data element (synonyms) which are permitted to remain in the system. EDI eliminates the need for aliases because, although different users may have different names for the same data element, they can provide for "translation" to the standard by means of the software they design to interface their unique system to the EDI standard.

The development of the logical schema consists of defining data segments and their relationships. Figure 4.11 and figure 4.12 are samples of two EDI tables which list data segments and the data elements from which they are built. [Ref. 19]. In Table 3 (figure 4.11) the data segment titled "beginning segment for completed payments" is assigned the segment ID number "B7". This data segment is composed of three data elements (see the right column). These data elements can be identified using Table 4 (figure 4.12) by finding the segment ID number "B7" in the first column. The second column lists each data element

DATA ELEMENTS

2 ACCEPTED SETS
(SPEC: TYPE= N MIN= 1; MAX= 3)
NUMBER OF TRANSACTIONS RECEIVED WITHOUT ERROR IN A FUNCTIONAL GROUP (NUMBER MAY BE 0)

REFERENCE DESIGNATOR(S): B502

3 FREE-FORM MESSAGE
(SPEC: TYPE= AN MIN= 1; MAX= 60)
FREE-FORM TEXT

ALSO SEE: NOTE REFERENCE CODE (363)

REFERENCE DESIGNATOR(S): K201 NTE02

6 ARRIVAL DATE
(SPEC: TYPE= N MIN= 6; MAX= 6)
DATE (YYMMDD) AS REQUIRED BY CUSTOMS
ALSO SEE: ETA DATE (45)

REFERENCE DESIGNATOR(S): X302

7 BANK ACCOUNT NUMBER
(SPEC: TYPE= N MIN= 6; MAX= 17)
ID NUMBER ASSIGNED BY BANK TO ITS CLIENT

REFERENCE DESIGNATOR(S): C205

8 BANK CLIENT CODE
(SPEC: TYPE= A MIN= 1; MAX= 1)
IDENTIFICATION OF PAYEE OR PAYER:

CODE	DEFINITION
E	PAYEE
R	PAYER

REFERENCE DESIGNATOR(S): C201

9 BANK PLAN NUMBER
(SPEC: TYPE= N MIN= 1; MAX= 6)
NUMBER ASSIGNED BY BANK TO PAYER'S FREIGHT PAYMENT ACCOUNT

REFERENCE DESIGNATOR(S): B605 B702

10 BANK TRANSACTION DATE
(SPEC: TYPE= N MIN= 6; MAX= 6)
DATE (YYMMDD) THE BANK RECORDED THE TRANSFER OF FUNDS

REFERENCE DESIGNATOR(S): B703

11 BILLING CODE
(SPEC: TYPE= A MIN= 1; MAX= 1)
TYPE OF BILLING REQUIREMENT FOR MULTIPLE EQUIPMENT SHIPMENT:

CODE	DEFINITION
A	TEMPORARILY ARTICULATED LOAD
M	MULTIPLE SHIPMENT BILLING
Q	MULTI-CAR TRANSIT
R	RULE 24 LEAD AND TRAILER EQUIPMENT ON SINGLE REVENUE BILL
S	SINGLE SHIPMENT BILLING
T	TRANSIT BILLING
U	UNIT TRAIN BILLING

REFERENCE DESIGNATOR(S): B211

12 BILLING DATE
(SPEC: TYPE= N MIN= 6; MAX= 6)
DATE (YYMMDD) OF THE CARRIER'S INVOICE

REFERENCE DESIGNATOR(S): B306 C004 R503

13 BOOKING NUMBER
(SPEC: TYPE= AN MIN= 1; MAX= 10)
NUMBER ASSIGNED BY THE CARRIER FOR SPACE RESERVATION

REFERENCE DESIGNATOR(S): Y301 Y401 Y501

14 CARRIAGE VALUE
(SPEC: TYPE= N MIN= 2; MAX= 8)
CARRIAGE VALUE EXPRESSED IN WHOLE UNITS OF THE STANDARD MONETARY DENOMINATION FOR THE CURRENCY SPECIFIED (IMPLIED DECIMAL POINT IS TO THE RIGHT OF THE EXPRESSED VALUE.)

REFERENCE DESIGNATOR(S): M102

15 CARR CERTIFICATED REL. DATE
(SPEC: TYPE= N MIN= 6; MAX= 6)
DATE (YYMMDD) OF CARRIER'S CERTIFICATE OF RELEASE AS REQUIRED BY CUSTOMS

REFERENCE DESIGNATOR(S): X303

18 CHARGE METHOD OF PAYMENT
(SPEC: TYPE= A MIN= 1; MAX= 1)
CODE DEFINING METHOD OF PAYMENT:

CODE	DEFINITION
A	PREPAID CASH
B	PREPAID CREDIT
C	COLLECT CASH
D	COLLECT CREDIT
E	COLLECT

REFERENCE DESIGNATOR(S): L111 L811

19 CITY NAME
(SPEC: TYPE= AN MIN= 2; MAX= 19)
FREE-FORM TEXT FOR CITY NAME

REFERENCE DESIGNATOR(S): D401 0701 E401 E701 F401 F701 F906 H502 L715 N401 NAM05 RIN04 S402 S903 T209 T210 T604 T607 2T03 U401 U901 V905 Y106

20 CLIENT BANK NUMBER
(SPEC: TYPE= N MIN= 3; MAX= 9)
FEDERAL RESERVE ROUTING CODE (SEE APPENDIX A-A4)

REFERENCE DESIGNATOR(S): C204

21 C.O.D. CURRENCY
(SPEC: TYPE= A MIN= 2; MAX= 2)
STANDARD ISO CODE FOR THE COUNTRY IN WHICH THE C.O.D. CURRENCY IS SPECIFIED (SEE APPENDIX A-A5)

REFERENCE DESIGNATOR(S): C305 C701

22 COMMODITY CODE
(SPEC: TYPE= AN MIN= 2; MAX= 10)
ALPHA/NUMERIC CODE USED TO DESCRIBE A COMMODITY OR GROUP OF COMMODITIES FOR RATING AND BILLING PURPOSES
ALSO SEE: COMMODITY CODE QUALIFIER (23)

REFERENCE DESIGNATOR(S): E607 L503 1R03 1R04 1R05 1R06 1R07 TD104 9T01 H0111 H203

23 COMMODITY CODE QUALIFIER
(SPEC: TYPE= A MIN= 1; MAX= 1)
QUALIFIER FOR THE COMMODITY CODING SYSTEM USED TO DEFINE THE ITEM LADING DESCRIPTION (SEE APPENDIX A-A6 THRU A13, A33)

CODE	DEFINITION
A	SCHEDULE A, TARIFF SCHEDULES OF THE UNITED STATES ANNOTATED
B	U.S. FOREIGN TRADE SCHEDULE B, STATISTICAL CLASSIFICATION OF DOMESTIC AND FOREIGN COMMODITIES EXPORTED FROM THE UNITED STATES
C	CANADIAN FREIGHT CLASSIFICATION
E	COORDINATED MOTOR FREIGHT CLASSIFICATION
H	BRUSSELS NOMENCLATURE HARMONIZED SYSTEM (HARMONIZED BTN)
M	MUTUALLY DEFINED
N	NATIONAL MOTOR FREIGHT CLASSIFICATION (NMFC)
S	STANDARD INTERNATIONAL TRADE CLASSI-

Figure 4.10 Data Dictionary.

associated with the data segment and the third column indicates whether the data element is mandatory (M), optional (O), or conditional (C). Additional information is contained in the remaining columns. These tables are used in conjunction with the data dictionary which describes individual data elements, to form the logical schema.

To define processing, transactions should be defined. Transactions represent events in the real world and in EDI transaction sets represent paperwork which document a real world event. Transaction sets are defined in terms of the data segments from which they are built. in a sense this is an extension of the logical schema. Figures 4.13 and figure 4.14 are a sample of two EDI tables which list transaction sets and the data segments they include [Ref. 19]. In Table 1 (figure 4.13) the transaction set titled "flight confirmation" is assigned set ID number "101". This transaction set is composed of eight data segments. These data segments can be identified using Table 2 (figure 4.14) by finding the set title "flight confirmation" and the set ID number "101". The second column under "flight confirmation" lists each data segment associated with the transaction set and the third column indicates whether its use is mandatory, optional, or conditional. Additional information is provided in the remaining columns.

The purpose of a design review is to identify flaws. Documentation from the previous stages is examined and problems are identified and recommendations for resolution are made.

2. Physical Data Base Design

Since EDI is not a data base management system as such, the steps of physical data base design apply only in a loose sense. The physical design differs from the logical design primarily in the sense that the physical schema provides for the implementation of the logical schema.

TABLE 3 - SEGMENT NAMES

TABLE 3 - SEGMENT NAMES

Segment Name	Segment ID	Data Elements (Table 4)
CONTROL HEADER (FUNCTIONAL GROUP)	XX	5
CONTROL TRAILER (FUNCTIONAL GROUP)	GE	3
ENDING SEGMENT (TRANSACTION SET)	SE	2
STARTING SEGMENT (UCS TRANSACTION SET)	STR	2
REJECTION	A1	4
BEGINNING SEGMENT FOR MANIFEST	BO	5
BEGINNING SEGMENT FOR BOOKING OR PICK-UP/DELIVERY	B1	3
BEGINNING SEGMENT FOR SHIPMENT INFORMATION TRANSACTION	B2	17
BEGINNING SEGMENT FOR CARRIERS INVOICE	B3	11
BEGINNING SEGMENT FOR INQUIRY OR REPLY	B4	8
BEGINNING SEGMENT FOR ACCEPTANCE/REJECTION	B5	4
BEGINNING SEGMENT FOR PAYERS AUTHORIZATION	B6	7
BEGINNING SEGMENT FOR COMPLETED PAYMENTS	B7	3
BEGINNING SEGMENT	B8	5
BEGINNING SEGMENT FOR REPETITIVE PATTERN MAINTENANCE	B9	8
BEGINNING SEGMENT FOR ADVANCE CONSIST	BA	5
BEGINNING SEGMENT FOR FILE TRANSFER INFORMATION	BGF	3
BEGINNING SEGMENT	BSG	2
FREIGHT PAYMENT	CD	4
COMPLETED PAYMENTS	C1	6
BANK ID	C2	7
CURRENCY	C3	6
COMMERCIAL INVOICE TOTAL PRICING	C7	3
COMMERCIAL INVOICE CERTIFICATIONS AND CLAUSES	C8	3
CONSIGNEE NAME	D1	4
CONSIGNEE ADDRESS	D2	2
CONSIGNEE CITY	D4	5
CONSIGNEES THIRD PARTY	D5	4
CONSIGNEES THIRD PARTY ADDRESS	D6	2
CONSIGNEES THIRD PARTY CITY	D7	4
DELIVERY ROAD CODE	D8	1
DESTINATION STATION	D9	4
DOCUMENT REFERENCES	DR1	6
EMPTY CAR DISPOSITION - PENDED DESTINATION CONSIGNEE	E1	3
EMPTY CAR DISPOSITION - PENDED DESTINATION CITY	E4	4
EMPTY CAR DISPOSITION - PENDED DESTINATION ROUTE	E5	4
EMPTY CAR ADVANCE DISPOSITION	E6	8
CAR HANDLING INFORMATION	E7	6
BLOCKING AND RESPONSE INFORMATION	E8	2
EXCHANGE RATE/ORDER ACCEPTANCE DATE	ERD	3
CONSIGNOR NAME	F1	4
CONSIGNOR ADDRESS	F2	2
CONSIGNOR CITY	F4	5
CONSIGNORS THIRD PARTY	F5	4
CONSIGNORS THIRD PARTY ADDRESS	F6	2
CONSIGNORS THIRD PARTY CITY	F7	4
ORIGIN STATION	F9	7
SHIPMENT TYPE INFORMATION	G1	3
BEYOND ROUTING	G2	2
BROKERAGE INFORMATION	G3	3
GOODS DETAILS	GDI	10
HAZARDOUS MATERIAL	H1	5
ADDITIONAL HAZARDOUS MATERIAL DESCRIPTION	H2	2
SPECIAL HANDLING INSTRUCTIONS	H3	4
CAR SERVICE ORDER	H5	3
INVOICE TERMS AND CONDITIONS	ITC	9
INVOICE ITEM LINE	ITL	6
REMARKS	K1	2
ADMINISTRATIVE MESSAGE	K2	1
FILE INFORMATION	K3	1
LINE ITEM - QUANTITY AND WEIGHT	LD	10
RATE AND CHARGES	L1	13
TARE WEIGHT	L2	2
TOTAL WEIGHT AND CHARGES	L3	10
MEASUREMENT	L4	4
DESCRIPTION, MARKS AND NUMBERS	L5	8
CARRIERS LINE ITEM REFERENCE NUMBER	L6	2
TARIFF REFERENCE	L7	16
LINE ITEM SUBTOTAL	L8	11
CHARGE DETAIL	L9	2
LETTER OF CREDIT REFERENCE	MO	3
INSURANCE	M1	6
SALES/DELIVERY TERMS	M2	6
RELEASE	M3	1
CONSOLIDATION MANIFEST INFORMATION	M4	5
MANIFEST LINE IDENTIFICATION DATA	M5	8
REPETITIVE PATTERN NUMBER	M6	4
SEAL NUMBERS	M7	4

Figure 4.11 List of Data Segments.

TABLE 4 —·DATA ELEMENTS IN EACH SEGMENT

TABLE 4 - DATA ELEMENTS IN EACH SEGMENT

Segment ID	Data Element	Require-ment	Special Process	Location in Master Record	
XX	142	M	O	-->	<--
XX	124	M	O	-->	<--
XX	29	M	O	-->	<--
XX	30	M	O	-->	<--
XX	28	M	O	-->	<--
GE	97	M	O	-->	<--
GE	96	C	O	-->	<--
GE	28	C	O	-->	<--
SE	96	M	A16	-->	<--
SE	329	C	A17	-->	<--
STR	143	M	O	-->	<--
STR	329	M	O	-->	<--
A1	131	M	O	-->	<--
A1	126	M	O	-->	<--
A1	44	M	O	-->	<--
A1	43	M	O	-->	<--
BO	143	M	O	-->	<--
BO	215	M	O	-->	<--
BO	214	M	O	-->	<--
BO	228	C	O	-->	<--
BO	91	C	O	-->	<--
B1	143	M	O	-->	<--
B1	145	M	O	-->	<--
B1	239	C	O	-->	<--
B2	143	M	O	-->	<--
B2	298	M	O	-->	<--
B2	154	O	O	-->	<--
B2	223	O	E0405	-->	<--
B2	129	O	E0405	-->	<--
B2	145	O	O	-->	<--
B2	188	C	O	-->	<--
B2	146	M	O	-->	<--
B2	160	O	O	-->	<--
B2	147	C	O	-->	<--
B2	11	O	O	-->	<--
B2	226	O	O	-->	<--
B2	195	O	O	-->	<--
B2	199	O	O	-->	<--
B2	57	O	O	-->	<--
B2	86	C	O	-->	<--
B2	460	O	O	-->	<--
B3	143	M	O	-->	<--
B3	76	M	O	-->	<--
B3	145	C	O	-->	<--
B3	146	M	O	-->	<--
B3	188	C	O	-->	<--
B3	12	M	O	-->	<--
B3	193	O	O	-->	<--
B3	202	O	O	-->	<--
B3	32	O	P0910	-->	<--
B3	33	C	P0910	-->	<--
B3	140	C	O	-->	<--
B4	143	M	O	-->	<--
B4	71	C	O	-->	<--
B4	157	C	CON3	-->	<--
B4	158	C	O	-->	<--
B4	161	C	O	-->	<--
B4	159	C	O	-->	<--
B4	206	C	CON7	-->	<--
B4	207	C	P0708	-->	<--
B5	143	M	O	-->	<--
B5	2	M	O	-->	<--
B5	123	M	O	-->	<--
B5	28	M	O	-->	<--
B6	143	M	O	-->	<--
B6	145	M	O	-->	<--
B6	75	M	O	-->	<--
B6	76	C	O	-->	<--
B6	9	C	O	-->	<--
B6	245	O	O	-->	<--
B6	249	C	O	-->	<--
B7	143	M	O	-->	<--
B7	9	M	O	-->	<--
B7	10	M	O	-->	<--
BB	143	M	O	-->	<--
BB	128	M	O	-->	<--
BB	127	M	O	-->	<--
BB	125	M	O	-->	<--
BB	188	C	O	-->	<--

Figure 4.12 Data Elements in Each Data Segment.

TABLE 1 - SET NAMES

Set Name	Set ID	Segment (Table 2)
FLIGHT CONFIRMATION	101	8
SHIPMENT INFORMATION (AIR)	104	40
CONTAINER/EQUIPMENT TRANSFER (AIR)	105	7
SHIPMENT INFORMATION FOR EXPORT DECLARATION (AIR)	107	33
SHIPMENT INFORMATION FOR IMPORT (AIR)	108	37
SHIPMENT INFORMATION FOR PICK-UP/DELIVERY ORDER (AIR)	109	14
FREIGHT DETAILS AND INVOICE (AIR)	110	32
FREIGHT DETAILS AND INVOICE SUMMARY (AIR)	111	8
INQUIRY (AIR)	113	5
SHIPMENT IDENTITIES AND STATUS REPLY (AIR)	114	6
STATUS DETAILS REPLY (AIR)	115	9
REPETITIVE PATTERN MAINTENANCE (AIR)	116	33
SHIPMENT INFORMATION (MOTOR)	204	31
CONTAINER/EQUIPMENT TRANSFER (MOTOR)	205	8
SHIPMENT PICK-UP ORDER (MOTOR)	206	13
SHIPMENT INFORMATION FOR EXPORT DECLARATION (MOTOR)	207	18
SHIPMENT INFORMATION FOR IMPORT (MOTOR)	208	21
FREIGHT DETAILS AND INVOICE (MOTOR)	210	39
FREIGHT DETAILS AND INVOICE SUMMARY (MOTOR)	211	7
INQUIRY (MOTOR)	213	3
SHIPMENT IDENTITIES AND STATUS REPLY (MOTOR)	214	9
REPETITIVE PATTERN MAINTENANCE (MOTOR)	216	22
RESERVATION (BOOKING REQUEST - OCEAN)	300	19
CONFIRMATION (OCEAN)	301	17
CONTAINER/SPECIALIZED EQUIPMENT PICK-UP ORDER/CANCELLATION	302	10
CANCELLATION (OCEAN)	303	5
SHIPMENT INFORMATION (OCEAN)	304	39
CONTAINER/EQUIPMENT TRANSFER (OCEAN)	305	9
DOCK RECEIPT	306	23
SHIPMENT INFORMATION FOR EXPORT DECLARATION (OCEAN)	307	22
SHIPMENT INFORMATION FOR IMPORT (OCEAN)	308	28
FREIGHT DETAILS AND INVOICE (OCEAN)	310	30
ARRIVAL NOTICE (OCEAN)	312	23
INQUIRY (OCEAN)	313	4
SHIPMENT IDENTITIES AND STATUS REPLY (OCEAN)	314	6
STATUS DETAILS REPLY (OCEAN)	315	7
REPETITIVE PATTERN MAINTENANCE (OCEAN)	316	19
SHIPMENT INFORMATION (RAIL)	404	51
SHIPMENT INFORMATION FOR EXPORT DECLARATION (RAIL)	407	32
SHIPMENT INFORMATION FOR IMPORT (RAIL)	408	35
FREIGHT DETAILS AND INVOICE (RAIL)	410	46
FREIGHT DETAILS AND INVOICE SUMMARY (RAIL)	411	7
STATUS INQUIRY (RAIL)	413	3
STATUS INFORMATION (RAIL)	414	10
FLEET REFERENCE UPDATE	415	4
REPETITIVE PATTERN MAINTENANCE (RAIL)	416	36
WAYBILL INTERCHANGE (RAIL)	417	53
ADVANCE INTERCHANGE CONSIST	418	4
EMPTY CAR ADVANCE DISPOSITION	419	8
CAR HANDLING INFORMATION	420	10
COMMERCIAL INVOICING	800	13
PAYMENT AUTHORIZATION	900	9
COMPLETED PAYMENTS	901	4
PAYMENT ADVICE	902	8
CONSOLIDATION MANIFEST	950	12
STATUS INFORMATION FROM CONSOLIDATOR	951	4
GENERALIZED FEEDBACK	990	5
ADVISORY INFORMATION	995	4
FILE TRANSFER	996	3
SET CANCELLATION	998	2
ACCEPTANCE/REJECTION ADVICE	999	4

Figure 4.13 List of Transaction Sets.

FLIGHT CONFIRMATION

Set ID	Segment ID	Requirement	Maximum Use	Special Process	Loop Control	Loop Index
101	B1	M	1	0	0	0
101	N9	O	20	0	0	0
101	R6	O	9	0	0	0
101	L9	O	40	0	0	0
101	Y1	O	2	0	0	0
101	Q1	O	1	0	0	0
101	K1	O	2	0	0	0
101	SE	M	1	0	0	0

SHIPMENT INFORMATION (AIR)

Set ID	Segment ID	Requirement	Maximum Use	Special Process	Loop Control	Loop Index
104	B2	M	1	0	0	0
104	N9	C	2	P36	0	0
104	N7	C	1	0	1041	25
104	M7	O	1	0	1041	0
104	M1	C	1	0	0	0
104	M2	C	1	0	0	0
104	C2	C	1	P6	0	0
104	C3	C	1	P7	0	0
104	F1	C	1	0	0	0
104	F2	C	1	P26	0	0
104	F4	C	1	0	0	0
104	D1	C	1	0	0	0
104	D2	C	1	P26	0	0
104	D4	C	1	0	0	0
104	U1	C	1	0	0	0
104	U2	C	1	P26	0	0
104	U4	C	1	0	0	0
104	U5	C	1	0	0	0
104	U6	C	1	P26	0	0
104	U9	C	1	0	0	0
104	F5	C	1	P5	1042	10
104	F6	C	1	P26	1042	0
104	F7	C	1	0	1042	0
104	D5	C	1	P5	1043	10
104	D6	C	1	P26	1043	0
104	D7	C	1	0	1043	0
104	R1	C	1	0	0	0
104	H1	C	3	0	0	0
104	H2	C	2	P11	0	0
104	H3	C	6	0	0	0
104	L5	C	10	0	1044	25
104	LO	C	10	P28	1044	0
104	L1	C	10	P28	1044	0
104	L4	C	10	0	1044	0
104	L7	O	10	P28	1044	0
104	X1	C	1	0	1044	0
104	X2	C	1	P12	1044	0
104	L3	C	1	0	0	0
104	K1	O	2	0	0	0
104	SE	M	1	0	0	0

CONTAINER/EQUIPMENT TRANSFER (AIR)

Set ID	Segment ID	Requirement	Maximum Use	Special Process	Loop Control	Loop Index
105	B8	M	1	0	0	0
105	N9	M	1	P17	0	0
105	N9	M	1	P18	0	0
105	D5	M	1	P19	0	0
105	D6	C	1	P26	0	0
105	D7	M	1	0	0	0
105	SE	M	1	0	0	0

Figure 4.14 Data Segments in Each Transaction Set.

a. output

The outputs of the physical design are the physical schema and the definition of user views. The physical schema includes specific data structures (e.g. linked list or inverted lists) and the necessary algorithms to maintain and manage the data base. The physical schema is in executable form. The definition of user views in the EDI sense would be the interface software which would link a unique data base at a specific command to the EDI standard in order to translate the data for transmission.

3. Summary

The design effort required to implement an EDI interface within the WWMCCS community is really at two levels. At the joint community level a logical design must be produced by the users and a physical schema by the appropriate technical experts. At the command level software must be developed to interface command unique data bases to the EDI standard in order to enable commands to successfully exchange data while still preserving their unique systems.

V. SUMMARY

One of the major problems in WWMCCS ADP today is the inability to meet the requirement for timely exchange of data among widely separated commands in a time sensitive environment while preserving security and accuracy. The current method is to have commands use their unique applications for individual processing requirements and then use one of a few standard applications in order to interface with other commands in a form which can be interpreted by them. This method entails many problems, not the least of which is a requirement for manual intervention to translate data among various applications. Manual intervention increases the likelihood of problems with timeliness, accuracy, and security.

By implementing the EDI concept the members of the WWMCCS community could substantially reduce these problems by reducing the requirement for special interfaces (manual or automated) between each set of applications which need to exchange data. By using the EDI concept, any command which could translate to and from the EDI standard data set could exchange data with any other participating command.

Figure 5.1 shows how data sets are exchanged among commands today. each dotted line represents an interface program designed to "translate" data between an application at one command and an application at another. Today if MSC is to furnish information directly to three applications at other commands (e.g. MTMC, JDA, MAC) special interface software must be written or all commands must be restricted to using the same software and hardware. In addition, if any other commands needed to exchange data, they would need additional software to facilitate those interfaces (eg. MTMC

and JDA). Figure 5.2 Indicates how data would be exchanged using the EDI concept. A sample data exchange using data will serve to further illustrate the function of the EDI standard data set.

```
MAC. . . . . . MSC . . . . . .MTMC
                .
                .
                .
                .
               JDA
```

Figure 5.1 WWMCCS Interfaces Today.

```
                         MSC   (2250061285)
                                  .
                                  .
                                  .
                                  .
MAC (850612) . . .  EDI   (120685)   . . . MTMC   (120685)
```

Figure 5.2 Data Exchange Using EDI.

MSC is required to transmit information which contains in it a data element which represents a date. They transmit this information to JDA, MTMC, and MAC. Due to their unique applications, MSC represents this date as hour-minutes-month-day-year (eg. 2250061285).

The MSC-EDI interface translates this to the EDI standard for date which is expressed (by community agreement) as day-month-year (eg. 120685).

The EDI software packages the information for transmission and sends it to the appropriate commands.

When the data is received at JDA, they translate, using command software, into the format required by unique applications at JDA (eg. year-month-day 850612). When the data is received at MTMC it is used in the EDI format.

The most obvious advantage is that if MTMC also interfaces with JDA no additional interfaces would be required using the EDI concept.

The EDI system provides for the transmission of the data in a standard format. Each command provides the means of translating their data to to and from the standard with command unique software. This does, however, reduce the number of required interfaces and permits reduction of duplication in establishing a distributed data base approach. Each command will only require one interface, regardless of the total number of commands participating. Under the current system, if each command is to exchange data with every other participating command the total number of interfaces required for each command would be N-1 (where N represents the number of commands participating). The EDI standard tables could contain codes indicating which command is responsible for certain kinds of transaction sets or data segments and to whom these are distributed. In addition, when information is requested through the EDI interface, the central directory would have the means to locate the appropriate command from which to draw the information. This would reduce the require ment for each command to maintain individual data directories for all the commands with which they interface. The use of a common interface permits many widely separated data bases to function virtually as a distributed data base. This will help meet the identified requirement for a distributed data base approach to support JOPES. It is not a distributed data base in the routine sense but rather an interface which permits the exchange of data among separate data bases.

The EDI concept does work. It is being used in the transportation industry today. Figure 5.3 and Figure 5.4 are provided as a further illustration of its application [Ref. 21]. In figure 5.3 the sender types information into a terminal in the format required by the individual organization (in this case using a forms mode and "filling in the blanks"). Figure 5.4 shows how the same data appears when it has been converted into EDI standard data elements and data segments by means of the table driven EDI system.

Use of the EDI concept in WWMCCS would require high level support and commitment throughout the joint community. The initial effort to develop standard data sets and prepare command interfaces is indeed significant. However, since it will provide the capability to exchange data among commands using various hardware, software, and data base management systems, it has the obvious advantage of providing much needed flexibiltiy. Commands would be able to utilize state of the art ADP technology to solve their unique command and control ADP requirements without sacrificing the capability to exchange data effectively with other commands. By providing for data transfer without requiring standarization and duplication of applications and data bases, EDI supports more efficient use of ADP resources. The EDI concept can help sove the data exchange problems in WWMCCS ADP today and contribute toward fullfilment of evolving requirements for exchanging data among commands.

I N V O I C E

(Sample)

ABC Company, Inc., Anytown, California

(UCS Number 1234567890001)

BILL TO:
Sales Company
(UCS # 9876543210002)
Attn: Accounting Dept.
1964 Madison Ave.
Freemountain, CA 94533

INVOICE NUMBER:
4487221

SHIP TO:
Sales Company
(UCS # 9876543210070)
Grocery Warehouse # 70
22 West Long St.
Richland, CA 94500

PURCHASE ORDER NUMBER:
9C3417

INVOICE DATE:
15 Oct 1982

TERMS:
2% 10 Net 30

QUANTITY	UNIT	UPC NUMBER	VENDOR UNIT PACK & SIZE	DESCRIPTION	LIST COST	UNIT ALLOW.	EXTENTION
10	CS	0007139912345	24/16 OZ	ABC Tropl Fruit Salad	13.17		131.70
1	CS	0007139912345	24/16 OZ	ABC Tropl Fruit Salad	NC		0.00
30	CS	0007139967890	24/8 OZ	ABC Cut Green Beans	9.76		292.80

TOTAL: $424.50

SPECIAL INSTRUCTIONS:

CONTACT:

Figure 5.3 Transmission as Submitted.

TRANSACTION SET EXAMPLE - INVOICE # 44887221

```
(BG SEGMENT)
(GS SEGMENT)
     .
     .
     .
ST*880*--------
G01*821016*44887221*820928*903417
LS*0100
N1*BT**9*98765432 10002
N1*ST*SALES COMPANY*9*98765432 10070
N2*GROCERY WAREHOUSE # 70
N3*22 WEST LONG ST
N4*RICHLAND*CA*94800
N1*BY**9*98765432 10001
N1*SU*ABC COMPANY, INC*9*123456789000 1
LE*0100
LS*0200
G17*11*CA*131700*003713912345
G69*ABC TRPCL FRUIT SALAD
G20*24*1600*OZ
LS*0210
G72*1*02**-131700****1000*CA
LE*0210
G17*30*CA*97600*003713967890
G69*ABC CUT GREEN BEANS
G20*24*800*OZ
LE*0200
G23*01*3*2000**10**30
G25*PB*03
G31*41*CA
G33*42450*41601
SE*27*--------
     .
     .
(GE SEGMENT)
(EG SEGMENT)
```

Figure 5.4 Transmission in EDI Format.

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Washington, D.C. 20036

13. Mr. John F. O'Neil 1
Electronic Data Systems Corporation
Federal Systems Division
7450 Boston Boulevard
Springfield, Virginia 22152

14. WWMCCS Information System 1
Joint Program Management Office
Attn: LT Mary McLendon-Koenig
Washington, D.C. 20330

2' 8534

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